Chapter 4: Future Management Direction

Goals, Objectives and Strategies

The Environmental Assessment in Appendix A describes and analyzes a series of management alternatives: four for Mingo NWR, two for Pilot Knob NWR, and two for Ozark Cavefish NWR. The Service identifies one preferred alternative for each refuge. These preferred alternatives are described in the following chapter as the proposed future management direction that would guide activities on the three refuges for the next 15 years. In some cases the proposed future management direction describes initial steps of a long term vision that may take 100 years or more to achieve.

Goals, objectives, and strategies comprise the proposed future management direction. Goals are descriptive broad statements of desired future conditions that convey a purpose. There are six goals for Mingo NWR and two each for Pilot Knob NWR and Ozark Cavefish NWR. Goals are followed by objectives, specific statements that describe management intent. Objectives provide detail and are supported by rationale statements that describe background, history, assumptions, and technical details to help understand how the objective was formulated. Finally, beneath each objective are lists of strategies—specific actions, tools, and techniques required to fulfill the objective.

Bullfrog on Mingo NWR. USFWS

Mingo National Wildlife Refuge Goals, Objectives and Strategies

Goal 1: Habitat

The Refuge will actively conserve a mosaic of upland and wetland habitats, including designated wilderness, through appropriate management strategies that preserve, protect, and enhance the vitality and health of the natural environment.

Objective 1.1: Ditch System

Over the next 15 years, maintain the rate and volume of water movement at or above 2005 levels within a portion of Ditch 10 and all of Ditches 1, 2, 3, 5, 6, and 11, totaling approximately 34 miles, by ensuring that at least 75 percent of the depth along these stretches is free of sediment and the length is free of obstructions that impede water flow. Maintain rate and volume of water movement at or above 2005 levels within the remaining ditches based on measurements of water flow, sedimentation rates, and duration of flooding..

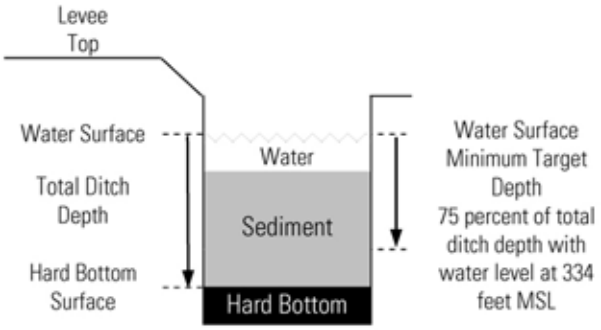
Supporting Rationale

Actions to improve water transport throughout the ditch network reduce flood duration and improve bottomland forest dynamics, helping meet the Refuge purpose of providing habitat for migratory birds. Floodwaters that once flowed across the entire Mingo basin are now channeled by ditches totaling more than 50 miles. Land use changes within much of the watershed that increased sedimentation rates prevent restoration of sprawling flow across the Mingo basin. The ditch network traps the increased amount of sediment that would choke existing habitats if carried by slower sprawling flow. Dikes and water control structures placed along the ditch system that assisted water management also reduced water velocity increasing the rate of sedimentation. A 1995 survey showed 5-7 feet of sediment accumulation throughout most of the ditch network. This diminished the ditch network's ability to transport and hold water causing prolonged flooding that adversely affected the bottomland forest as well as fish populations. Total ditch depth varies across the Refuge and is measured vertically from the water surface to the surface of harder underlying soils when the water level is at 334 feet MSL. See Figure 12.

Strategies:

1. Use an excavator to remove sediment from the ditches and pile it along adjacent banks.
2. Seek funding and full-time (1.0 FTE) heavy equipment operator to accelerate the rate of sediment removal.
3. Within 3 years of CCP approval, develop an MOU between Mingo NWR and Duck Creek Wildlife Management Area to manage water jointly, both for public use and habitat management.
4. Maintain thorough records of when each reach of each ditch was cleaned out. Monitor depths and widths of ditches over time to assess rate of future sedimentation and develop a timetable for systematic ditch maintenance.
5. Continually investigate possible ways of speeding up ditch cleaning or making it more efficient.
6. Repair, replace and upgrade water control structures (converting to bottom draw) as needed, including Ditch 2 pump.

Figure 12: Ditch Structure



7. Consider hiring a professional hydrologist and conducting an elevation survey to guide improvements to the drainage network.
8. Maintain levees after silt removal to provide maintenance access.
9. Plant cover crops on levees for wildlife use.
10. Place water control structure along Ditch 10.
11. Maintain spring drainage so that system is flushed from bottom of water column.

Objective 1.2: Forest

Over the long-term (100-200 years), on 15,547 acres of the Refuge, achieve a mosaic of bottomland hardwood stands of different age and structural classes distributed across a narrow elevation gradient ranging from 335.5-339.5 feet MSL with lower elevations dominated by bald cypress and water tupelo, mid elevations dominated by overcup oak and red maple, and upper elevations dominated by red oak species and willow oak. Within 15 years, ensure that approximately 20 percent (with a long-term target of 40 percent) of stands presently dominated by overcup oak, red maple and their associates are converting to red oak species, willow oak and their associates based on regeneration surveys.

Supporting Rationale

Land use practices and modifications to the hydrology of the Mingo basin over the past 120 years impeded drainage, causing seasonal flooding to persist for longer than had occurred historically (Heitmeyer et al. 1989). The prolonged flooding helped shift composition of bottomland hardwood forests towards species with greater

water tolerances, and largely eliminated regeneration resulting in single-aged mature stands. Changes to the drainage system now allow for water management that more closely resembles those earlier conditions and the restoration of species associated with those conditions. This objective represents the Refuge's intent to more actively manage bottomland forest habitat to benefit forest-dependent wildlife, especially certain species of migratory waterfowl, neotropical migratory birds and mammals (like swamp rabbit). The 15,547-acre objective represents an increase of 547 acres over existing acreage; the additional amount comes from conversion of 225 acres of open marsh and 322 acres of other open habitats.

Strategies for Green Tree Reservoirs (Pools 5, 7, and 8 totaling about 3,040 acres)

1. Continue to flood three Green Tree Reservoirs (Pools 5, 7, and 8), totaling 3,040 acres, for no more than 130 consecutive days between November and March. Drain water prior to growing season to encourage regeneration and avoid killing trees. Under dry conditions may hold water in Green Tree Reservoirs into spring.

Strategies for Bottomland Hardwoods (includes Green Tree Reservoirs)

2. Conduct forest surveys or inventories every 5 years to monitor changes in health, composition, and structure of lowland and upland forests.
3. Develop and implement 5-year forest management plan.
4. Manage timber to promote regeneration of willow oak, pin oak, and red oak.
5. As indicated, conduct forest management activities such as thinning dense stands or midstory and selective harvest on a small scale to allow for habitat diversity and opening of canopy to stimulate plant growth, regeneration and recruitment on forest floor.
6. Provide vernal pools where feasible.
7. Allow water levels to fluctuate between mid-December to April. Have areas flooded no more than 130 consecutive days between November and March.
8. Conduct a study to learn more about the hydrology and geomorphology of the Refuge.

Objective 1.3: Open Marsh

Over the next 15 years, maintain approximately 3,075 acres of open marsh habitat within Rockhouse Marsh (900 acres) and Monopoly Marsh (2,175 acres) comprised of a mixture of submergent vegetation such as coontail (*Ceratophyllum demersum*) and American pondweed (*Potamogeton nodosus*), floating vegetation such as water lily (*Nymphaea odorata*) and watershield (*Brasenia schreberi*), and emergent vegetation such as narrowleaf cattail (*Typha angustifolia*) and lizard's tail (*Saururus cernuus*), and convert approximately 225 acres of Monopoly Marsh from open marsh habitat to wet forest dominated by bald cypress and water tupelo.

Supporting Rationale

Monopoly and Rockhouse marshes encompass 3,300 acres of Refuge lands. These open marshes provide vital nesting, resting, and feeding habitat to a wide variety of waterfowl, shorebirds, and wading birds. Wood ducks utilize the marshes of Mingo throughout the year as they provide the proper habitat requirements for all life stages of this species and ducklings from over a 10 mile radius migrate to Monopoly every year. The marshes receive a combined total of over nine million waterfowl use days annually. Many other species of birds, reptiles, amphibians, fish, and mammals utilize the marshes on a regular basis.

Strategies:

1. Draw down Monopoly Marsh once every 5 years, shrinking the flooded area to 30 acres.
1. Draw down Monopoly Marsh incrementally over 10 years to progressively expose edge habitats allowing for eventual conversion of about 225 acres to bald cypress and water tupelo.
2. Accelerate removal of willow and promote fluctuating water levels via enhanced water level control capability.
3. Restore ingress/egress fish (and other aquatic species) passages to both marshes.
4. Consider that Monopoly Marsh is located within the Wilderness Area and manage accordingly, i.e. through use of minimal tools.
5. Drawdown Rockhouse Marsh to 334 feet MSL by May 15 every other year, and remove woody vegetation (willow) during drawdown. Reflood the marsh beginning on October 1.

6. Conduct vegetation surveys every 5 years to gauge success of reforestation along perimeter of Monopoly Marsh.
7. Conduct vegetation surveys every 2 years to monitor expansion of emergent vegetation in the basin including cut grass.

Objective 1.4: Open Water (excluding ditches)

Over the next 15 years, maintain the amount of open water at or above 2005 levels (9.2 miles of streams and 200 acres of other open water) within Red Mill Pond, May Pond, Fox Pond, Job Corps Lake, Stanley Creek, Mingo River, Lick Creek, and Cow Creek, and decrease the amount of open water in Gum Stump. Within 5 years increase the amount of open water by about 20 acres within the Binford Unit and increase the amount of structure within Fox Pond.

Supporting Rationale

Water not only drives the ecology of Mingo NWR, but is a valuable habitat type in its own right for innumerable invertebrates and all five orders of vertebrates, including many species of birds, mammals, amphibians, reptiles, and fish. Mingo's watershed is comprised of approximately 90 square miles which includes nearly 60 square miles outside of the Refuge boundary. The refuge is within the lower portion of the St. Francis River basin and acts as a storage reservoir or detention basin during periods of flooding. Most of the open water on the refuge exists due to impoundment by water control structures and/or levees and recharge is dependent upon runoff and direct precipitation. Water levels of Stanley Creek, the Mingo River, Red Mill Pond, and Gum Stump are managed in accordance with the Annual Water Management Plan.

Strategies

1. Continue to manage ponds, pools, and impoundments using the appropriate tools such as periodic drawdowns, vegetation removal, and levee and structure maintenance.
2. Ensure appropriate consultation and cooperation between fishery biologists and engineers in construction of open water on Binford Unit and in the rehabilitation of Hartz Pond.
3. Use tree drops in some ponds to create habitat structure and fish cover.
4. By 2010, construct about 20 acres of open water at Binford Unit to provide additional fishing opportunities.
5. By 2010, rehabilitate Hartz Pond for fishing opportunities.

Objective 1.5: Moist Soil Units

Over the next 15 years, manage Moist Soil Units to provide a diversity of native herbaceous plant foods such as wild millet (*Echinochloa* spp.), panic grass (*Panicum* spp.), sedges (*Cyperus* spp. and *Carex* spp.), and beggarticks (*Bidens* spp.) with an annual seed/rhizome/tuber production of at least 1,000 lbs/acre above ground and 600 lbs/acre below ground based on grid sampling as defined by Laubhan and Frederickson (1992).

Supporting Rationale

Moist soil management is a widespread practice for producing a diverse mixture of native herbaceous plant foods and invertebrates that has its origins at Mingo NWR (Frederickson and Taylor 1982). It partially mimics seasonal flooding that has long occurred in the lowlands of the Mingo basin, but moist soil units – areas impounded by levees, dikes, and structures that permit precise control of water levels – allow managers to consistently produce conditions favorable to growth of native plants. Seeds produced by these plants provide balanced nutrition for migrating waterfowl, and also provide food and habitat for other migratory birds and wildlife. The diverse mixture

Mingo National Wildlife Refuge

of native plants also creates conditions that produce abundant invertebrates, a high protein wildlife food source.

Strategies:

1. Disturb (through mowing, disking, fire, etc…) an average of one-third of Moist Soil Unit acreage annually to set back succession.
2. Moist soil units will be maintained in early successional native plant communities for the production of annual seed crops.
3. Flood Moist Soil Units in stages beginning in October or November, initially flooding one-third and progressively flooding more of each unit as waterfowl deplete the food supply until units are entirely inundated.
4. Maintain MSUs dry throughout the growing season to produce food for migratory birds.
5. Maintain pumps, dikes and water control structures in good working order.
6. Maintain units to demonstrate comparison practices for educational purposes.
7. Replace water control structures and slope sides of borrow pits, thereby increasing opportunities for wildlife observation and environmental education and research.
8. Develop waterfowl public educational seminars and tours course conducted by Leigh Frederickson and Micky Heitmeyer.
9. Develop MOU with MDC on management of Moist Soil Unit 11 (Luken Farm).
10. Explore land exchange with MDC for Luken Farm property.
11. Provide additional fall-flooded, shallow-water habitat for shorebirds when feasible.
12. Maintain stable water levels at 1 to 6 inches across 80 to 90 acres of moist soil units from March through July 31 and encourage a mosaic of moist soil plants such as softstem bulrush (*Schoenoplectus tabernaemontani*), giant cutgrass (*Zizaniopsis miliacea*), prairie cordgrass (*Spartina pectinata*) and cattail (*Typus* spp.) to provide medium height cover (2-6 feet) interspersed with small areas of mud flats and shallow depressions as nesting habitat for King Rails.
13. With the exception of those acres managed for Black Rail and King Rail, begin draining moist soil units in March to expose mudflats by April to benefit migrating shorebirds which can feed on invertebrates.
14. Maintain stable water levels of 1 inch or less across 10 to 20 acres of moist soil units from April through August 15, and encourage a vegetative monotype of *Eleocharis* spp. (spikerushes), sedges, or other wetland/wet prairie grasses that provide dense low cover (2 feet or less) interspersed with small areas of mudflats and shallow depressions to provide nesting habitat for Black Rails.
15. Annually disturb the 10 to 20 acres of moist soil managed for Black Rails to remove unwanted vegetation while maintaining level ground capable of providing stable water levels of 1 inch or less.
16. Begin draining in March to expose mud flats by April to benefit migrating shorebirds that feed on the invertebrates.

Objective 1.6: Grassy Openings, Cropland, and Food Plots

Maintain 205 acres of grassy openings, 253 acres of cropland, and 73 acres of food plots. Convert the remaining 449 acres to cane (15 acres), oak savanna (112 acres), and young bottomland forest (322 acres), early successional habitats that would benefit species such as quail, turkey, doves, and swamp rabbits (see Figure 13 and Table 6). Within 15 years, develop a soft edge – a vegetative gradient from open to forested habitats – along the perimeters of these areas, and replace fescue with native vegetation.

Supporting Rationale

Grassy openings, cropland, and food plots located mostly around the perimeter of the Refuge partially simulate lost native habitat. The Refuge is situated at the interface of the Ozark Highlands and Crowley's Ridge, encompassing portions of each along with the bottomlands between. Temporary and permanent forest openings are part of the historic vegetative condition of the Refuge.

Fire, wind, and other disturbance agents likely kept about 3-5 percent (450-750 acres at Mingo NWR) of bottomland forests in temporary openings (Heitmeyer et al, 2005; Hartshorne, 1980; Heitmeyer et al, 1989; King and Antrobus, 2001). Caused by death or wind throw of one or more trees, such open habitats normally are quickly colonized by herbaceous plants, shrubs, and tree seedlings. These temporary openings provide diversity within the otherwise forested matrix, and are important habitat for wildlife such as swamp rabbits and Swainson's warblers. At Mingo NWR, years of prolonged annual floods caused by poor drainage impeded col-

Figure 13: Locations and Future Cover Type Allocations of Grassy Openings, Cropland and Food Plots, Mingo NWR

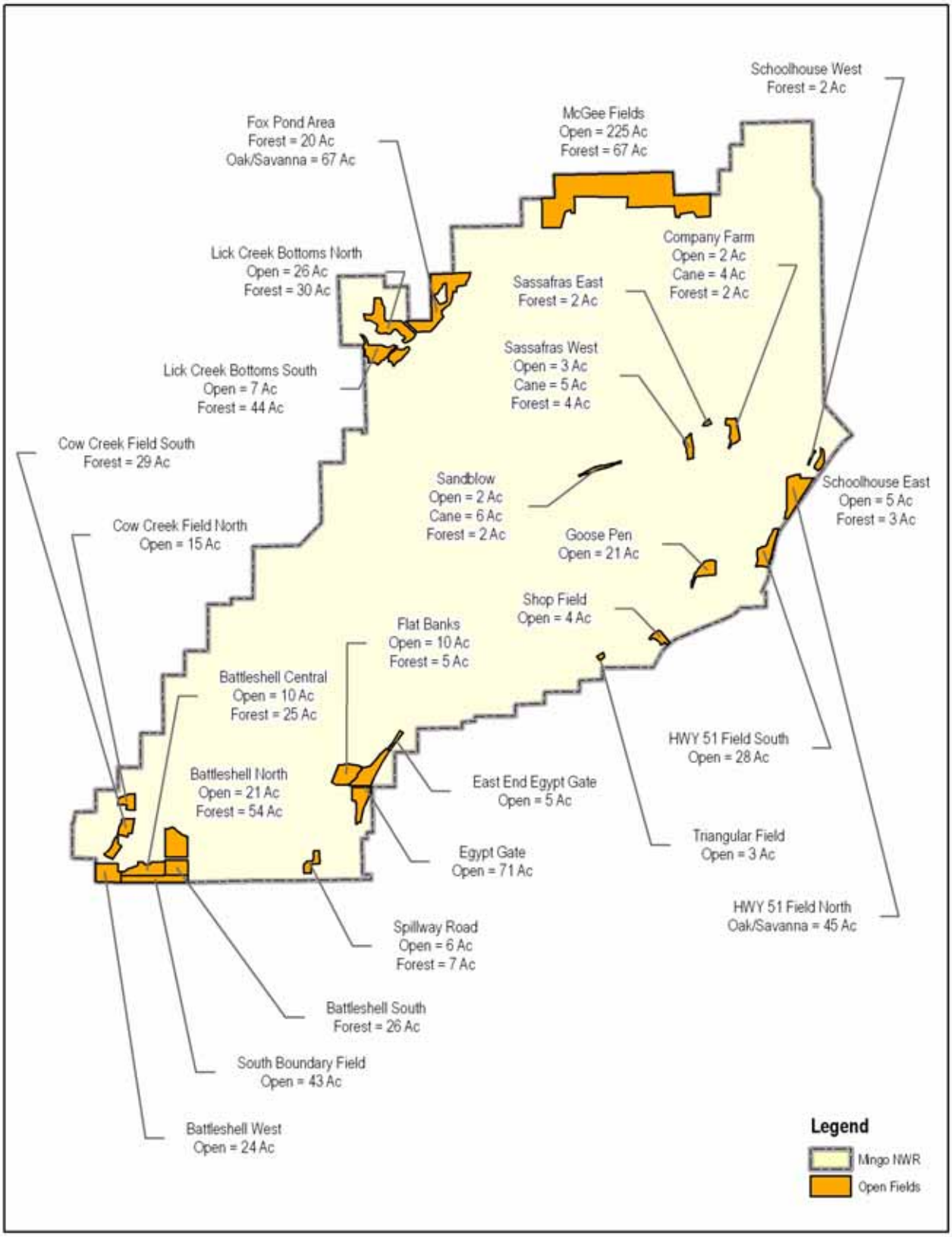


Table 6: Current and Future Condition of Mingo NWR Openings

	Current Condition		Future Condition	
Name	**Habitat Type**	**Acres**	**Habitat Type**	**Acres**
Schoolhouse East	Food Plot	8	Shrub/Forest	3
			Food Plots	5
Schoolhouse West	Food Plot	2	Shrub/Forest	2
Company Farm	Food Plot	8	Shrub/Forest (early succession)	2
			Cane Restoration	4
			Food Plot	2
Sassafras-East	Food Plot	2	Shrub/Forest	2
Sassafras-West	Food Plot	12	Shrub/Forest (early succession)	4
			Cane Restoration	5
			Food Plot	3
Sandblow	Food Plot	10	Short grass prairie with forbs	2
			Cane Restoration	6
			Shrub/Forest (early succession)	2
Lick Creek Bottoms North	Fallow Field and Cropland	56	Shrub/Forest (early succession) with scoured wetlands	30
			Old Field with scoured wetlands	18
			Food Plot	8
Goose Pen	Food Plot	21	Food Plot	21
Triangular Field	Food Plot	3	Food Plot	3
East end Egypt Gate	Food Plot	5	Food Plot	5
Flat Banks	Shrub/Forest	18	Shrub/Forest	23
	Food Plot	15	Food Plot	10
Spillway Road	Fallow Field	4	North End Shrub/Forest	7
	Food Plot	9	South End Food Plot	6
Battleshell North	Fallow Field	75	Shrub/Forest	34
			Shrub/Forest (early succession with scoured wetlands)	20
			Grassy Opening	21
McGee Fields	Cropland	292	Cropland	225
			Shrub/Forest	67
Fox Pond area	Fallow Field	87	Shrub/Forest	20
			Grassy opening with scattered trees	67
Lick Creek Bottoms South	Fallow Field	51	Sedge meadow	7
			Shrub/ Forest	44
Cow Creek Field North	Fallow Field	15	Sedge meadow	15
Cow Creek Field South	Fallow Field	29	Shrub/Forest	29

Table 6: Current and Future Condition of Mingo NWR Openings

	Current Condition		Future Condition	
Name	Habitat Type	Acres	Habitat Type	Acres
Battleshell Central	Cropland	35	Food Plot	10
			Shrub/Forest	25
Egypt Gate	Fallow Field	71	Convert higher elevations to mixed grass prairie	41
			Lower elevations to be maintained as grassy openings	30
HWY 51 Field South	Cropland	28	Cropland (1/2 idle in alternating years)	28
HWY 51 Field North	Fallow Field	45	Grassy opening with scoured wetlands)	45
Shop Field	Fallow field	4	Grassy Opening	4
Battleshell South	Fallow Field	26	Scrub/Forest	26
South Boundary Field	Fallow Field	43	Grassy opening	43
Battleshell West	Fallow Field	24	Grassy opening	24

onization of these openings by plants and young trees, eliminating much of this habitat. Food plots and cropland largely around the perimeter of the Refuge provide partial replacement of this lost habitat as well as wildlife viewing opportunities for visitors. Over the life of the plan (15 years), the need to maintain these permanent openings is expected to diminish as improvements to the ditch system (Objective 1.1) and changes in forest management (Objective 1.2) restore bottomland forest dynamics.

Grassy openings are part of the historic vegetative condition within the portions of the Refuge that grade into the bluffs of the Ozark Highlands on the west and Crowley's Ridge on the east (Dr. Leigh Fredrickson and Dr. Micky Heitmeyer, personal communication). Invasive species such as fescue quickly colonize these areas crowding out native species. Periodic farming is one low cost method used to disturb these sites and temporarily diminish the amount of invasive plant cover. On these sites, totaling about 205 acres, farming typically occurs for 1-2 years followed by a 2-3 year fallow period during which native species dominate.

Strategies:

1. Maintain cooperative agreements, which require cooperating farmers to leave 33 percent of the corn, milo, or 100 percent of winter wheat or clover for wintering waterfowl and resident species.
2. Mow fields as often as necessary to set back encroaching woody growth.
3. Provide food sources in upland openings for wildlife use during inclement weather.
4. Utilize mowing/haying to create and maintain forage.
5. Mow or plant food plots to provide for expanded opportunities for wildlife observation by public.
6. Seek partnerships to enhance funding and staffing resources to replace cooperative farming program to maintain open areas and provide early successional edge habitat.
7. Plant mast trees to speed succession of open areas.

Objective 1.7: Invasive/Exotic/Nuisance Plants

Annually work to maintain exotic or invasive vegetation on the Refuge at or below levels to be determined within 2 years of plan approval (of present concern are Johnson grass, *Sericea lespedeza*, bull thistle, reed canary grass, autumn olive, and multiflora rose).

Supporting Rationale

Exotic or non-native plants are those that have been deliberately or inadvertently transported and transplanted by humans outside their native range, often found on another continent. Certain exotic plants become "invasive" if they survive and begin to spread on their own, in the absence of the population controls (e.g. diseases, parasites, environmental constraints, organisms that fed on them) that held their propagation in check

in their native ranges. Invasive exotics are troublesome because they displace native vegetation on which native animal species have come to depend over many millennia of adaptation and coevolution. Refuge staff attempts to slow the spread of these invasive plants by a variety of mechanical and chemical means. Success will be determined based on factors which include reduction in spreading, shrinkage of infestation, complete eradication, and/or stabilization of infestation depending on the individual species, its negative impacts, and the feasibility of control.

Strategies:

1. Actively communicate with other state and federal resources agencies, as well as non-governmental organizations, to stay abreast of emerging exotic threats, as well as management strategies and techniques.
2. Coordinate control strategies with Regional Office and other state and federal agencies.
3. Maintain good records of control efforts and results.
4. Complete a comprehensive inventory to assess invasive plant infestations.
5. Use mechanical, chemical, and biological controls to slow the spread of invasive plant species.

Goal 2: Wildlife

The Refuge will provide for a diversity of migratory birds and native fish and wildlife associated with healthy Refuge habitats and contributing to the mission of the National Wildlife Refuge System.

Objective 2.1: Migratory Bird Monitoring

Within 3 years of plan approval, implement a monitoring program to establish abundance, population trends, and habitat associations of selected migratory bird species or groups of species (e.g. waterfowl, migrating land birds, shorebirds, marsh birds).

Supporting Rationale:

Mingo NWR was established under the Migratory Bird Treaty Act, so that its very purpose is to conserve habitat for and populations of migratory birds, including waterfowl, shorebirds, and neotropical birds. Forty-four species of waterfowl have been documented on the Refuge at one season or another. Most of these birds are migrants, either passing through Mingo NWR on journeys north and south in the spring and fall, or wintering on the Refuge. Three species of waterfowl are known to breed at the Refuge: Canada Goose, Wood Duck, and Hooded Merganser. In addition, the Green-winged Teal, Mallard, Northern Pintail, Northern Shoveler, Gadwall, American Widgeon, and Ring-necked Duck are listed as common or abundant at Mingo NWR during at least one season.

About 20 species of shorebirds use the Refuge at least one season of the year; of these, seven species – including the Killdeer, Lesser Yellowlegs, Spotted Sandpiper, Solitary Sandpiper, Pectoral Sandpiper, Common Snipe and American Woodcock – are listed as common at least one season of the year. The last two species (Common Snipe and Amercian Woodcock) tend to be found in moist or swampy wooded areas while the others favor the shorelines of shallow, open marshes.

Mingo NWR also sports a number of species of passerines (perching birds) and songbirds – notably the warblers, but also tanagers, thrushes, and others – that are neotropical migrants, breeding in the summer in North America and wintering in Central America, the Caribbean, and South America. Most of these neotropical migrants depend on wooded habitats. Some of the neotropical migrants breed at Mingo NWR but many others pass through the Refuge in the spring and fall.

Strategies:

1. Conduct waterfowl surveys, Bald Eagle surveys, Christmas Bird Counts, and breeding bird surveys.
2. Conduct shorebird surveys using the International Shorebird Survey Protocol to track occurrence, relative abundance, and response to management regimes.
3. Develop an Inventory and Monitoring step-down management plan based on direction contained in part 701 FW 2 of the Fish and Wildlife Service Manual.
4. Partner with conservation and private organizations to assist with monitoring, inventory, and educational efforts.
5. Conduct pre- and post-bird monitoring in conjunction with habitat management efforts including conversions and restoration/regeneration efforts.

Objective 2.2: Fish/Aquatic Species

Over the next 15 years, create or maintain diverse, self-sustaining fisheries in Refuge ponds,

streams, and ditches; and within 4 years begin reintroduction of extirpated, native species (of present interest is alligator gar) to help restore aquatic ecosystems to historic conditions.

Supporting Rationale

The Refuge has a rich historic diversity and abundance of swamp-dependent fisheries species. Previous Refuge surveys identified over 38 species, including alligator gar. A 2005 survey identified an additional nine species bringing the Refuge total to 46 fish species, many of which are limited to swamp habitat. Since the loss of nearly 2.5 million acres of bottomland swamp habitat in the Bootheel, many swamp dependent species have been restricted to isolated areas. On the Refuge, many species are described as locally abundant, but are rare State-wide. This would include such species as bantam sunfish, banded pygmy sunfish, flier, swamp darter, cypress darter, dollar sunfish, slough darter, and brown bullhead. Changes in the Lake Wappapello Corps of Engineers Project discharge rates and the construction of the Spillway Water Control Structure several feet above the bottom of the ditch have prevented fish movement and natural restocking of the impounded system of the Refuge. In addition, several of the interior water control structures on the Refuge serve as fish barriers preventing natural migration. These conditions compounded with an acceleration of the accumulation of sediment in the ditch system since the early 1980s caused shifts in abundance and diversity of fish species. Water clarity and dissolved oxygen levels decreased along with populations of most popular sport fish. Although surveys are lacking, it is likely diminished water quality also caused declines in numbers of freshwater mussels. Ditch restoration efforts, beginning in 1999, have already shown improvements in abundance and diversity of fish species. The diverse habitats on the Refuge such as clear creeks, ponds, springs and small streams, temporary forest and meadow flooding, marshes, and ditches offer a mixture of habitats that help maintain a diverse aquatic system.

Strategies:

1. In cooperation with MDC, conduct annual population censuses of sport fishery using electro-shocking or other techniques.
2. Working with MDC, stock catfish and other native game fish in ditches and ponds as needed.
3. By 2009, reintroduce alligator gar to provide added sport fishing opportunities and to restore a critical component of the aquatic ecosystem.
4. By 2008, conduct a comprehensive aquatic resources survey in cooperation with MDC.
5. Improve fisheries resources at Fox Pond by creating a balanced and self-sustaining fishery.
6. Continue removal of barriers and modify existing water control structures to enhance fish passage.
7. Use tree drops in ditches at appropriate locations to create habitat structure and fish cover.
8. Work with COE to periodically modify water discharge rates from Wappapello Lake to enhance opportunities for fish passage at the Refuge spillway.
9. By 2015, restore and enhance mussel populations by allowing for reintroduction of host fish, through the modification of the spillway structure.

Objective 2.3: Reptiles and Amphibians

Within 3 years of plan approval, implement a monitoring program to establish abundance, population trends, and habitat associations of selected reptile and amphibian species.

Supporting Rationale

Due to its diversity of habitats and the ample supply of water, amphibians and reptiles abound at Mingo NWR. More than 65 species have been documented, including frogs, toads, salamanders, lizards, turtles, and snakes. Among the snakes are the venomous cottonmouth (all three subspecies), southern copperhead, and timber rattlesnake (two subspecies). Many of these species hibernate along the bluff on the perimeter of the Refuge. Several species of reptiles and amphibians that occur on Mingo are endangered or threatened either federally or at the state level including the alligator snapping turtle and the three-toed amphiuma. Amphibians are especially sensitive to changes in their environment and their populations are declining worldwide (Houlahan et al. 2000) (Wake 1991) (Blaustein 1994). Monitoring the health of reptile and amphibian populations at Mingo NWR may help detect other environmental problems. Baseline data on

Mingo Wilderness Area. USFWS

reptiles and amphibians that occur on Mingo NWR are outdated and some is unreliable.

Strategies:

1. Monitor reptile and amphibian migration mortality due to vehicular use along Auto Tour Route and modify the opening and closure of the route to minimize mortality.
2. With partners, conduct research on mortality, mercury levels, and habitat use and availability.
3. Provide or enhance vernal pool habitat.
4. Conduct pre- and post-monitoring in conjunction with habitat management efforts including conversions and restoration/regeneration efforts.
5. Partner with conservation and private organizations to assist with monitoring inventory and educational efforts.

Objective 2.4: Invasive/Exotic/Nuisance Animal

Annually work to maintain levels of exotic or invasive animals on the Refuge at or below levels to be determined within 2 years of plan approval (of present concern are nutria, beaver, and feral hogs).

Supporting Rationale

Beaver are native to the Refuge, but can cause problems by undermining roads, girdling trees, and plugging culverts and water control structures, which causes extensive flooding. The Refuge previously enlisted trappers to help control beaver numbers, but due to the successful expansion of river otter, a desirable species, trapping was discontinued to avoid accidental take. Refuge Staff currently dispose of nuisance beaver in problem areas as needed. Successful control of this species will be based on the reduction of the observation of beaver dams, reduction of flooding of sensitive habitats not intended to be flooded, reduction of complaints from adjacent landowners of beaver caused flooding, and decrease in the occurrence of road, levee, and water control structure damage from burrowing and dam and den construction.

The nutria is a large, dark-furred, semi-aquatic rodent native to southern South America and introduced into North America as early as 1899. It was first discovered on the Refuge in 2000. The nutria's relentless burrowing weakens dikes, levees, and other earthen structures. Nutria also feed on native vegetation and can cause damage when they occur in high numbers. Refuge Staff dispose of nutria whenever they are found. Presently, nutria do not occur in high numbers on the Refuge. Successful control of this species will be based upon the reduction of the observation of damage to wetland habitats from foraging of the rodent and decrease in the occurrence of road and levee damage from burrowing.

Feral hogs or swine have emerged as a serious problem on many national wildlife refuges in recent years. They both harm habitat and displace native wildlife. Feral swine are elusive and widely scattered in Missouri; moreover, they use heavy cover and are difficult to find (MDC, 2004b). Thus, hunting specifically for wild hogs is usually unproductive, but they can be hunted incidentally when hunting other animals. Because they cause damage to streams, undergrowth and wildlife, the Missouri Conservation Department as well as the Service, hope to enlist the public in helping to control or eradicate them. In some places, trapping hogs by luring them with bait into pens and then disposing of them has proven successful in reducing hog populations. Successful control of this species will be measured on number of incidental sightings and signs including tracks, routing areas, and wallows.

Strategies:

1. Control nutria and feral hogs on the Refuge.
2. Promote incidental hunting of hogs if the population expands.
3. Monitor beaver populations and control nuisance beaver.
4. Document habitat impacts and infrastructure damage caused by beavers, nutria, and feral hogs.

5. In cooperation with MDC and neighbors, consider the use of trapping to reduce feral hog numbers.

Objective 2.5: White-tailed Deer

Upon plan approval, manage the deer herd to sustain a healthy population ranging from 800-1,200 deer at a density considered optimal in this portion of Missouri (24-35 per square mile).

Supporting Rationale

The white-tailed deer is the only large native mammal that occurs at Mingo NWR. It is a species popular for both hunting and viewing, bringing in an estimated 21,000 visits in 2004. Deer management on Mingo is based on a large data set that spans over 15 years. Spotlight surveys, deer track surveys, deer exclosures, and harvest data are utilized and interpreted to determine population sizes and make management recommendations. Emigration and immigration can greatly alter population size and density and can be extremely variable from year to year. Food availability, mainly mast production, is largely responsible for these variations in deer demographics. Damage to surrounding landowners can occur during years of poor mast production if the population rises above the target level. Overpopulation of deer can lead to the damage of seedlings, especially oaks, which can impede regeneration success in the bottomland hardwood areas of the Refuge. Overgrazing can lead and contribute to changes in species composition which in turn can result in negative effects on other plant and animal species (Rooney and Waller 2002). A firm understanding of population size and strong management decisions based on annual survey information prevents these negative effects, while sustaining a viable population to satisfy the needs of the public.

Strategies:

1. Monitor the size and population density of the deer herd through surveys conducted in December and January and conduct presence/absence survey following closure of bow season.
2. Monitor Refuge exclosures for signs of habitat damage that would indicate that carrying capacity has been surpassed.
3. Evaluate the health of individual animals and herds using standard techniques.

Goal 3: Visitor Services

Provide a variety of wildlife-dependent recreational and educational opportunities to allow the public to enjoy the resources of the Refuge and support the National Wildlife Refuge System. (Figure 14)

Objective 3.1: Hunting

Within 4 years of plan approval, provide opportunities for approximately 4,200 hunting visits per year while maintaining sustainable resources and providing participants with minimal conflicts with other user groups.

Supporting Rationale

As one of the six priority recreational uses identified in the *National Wildlife Refuge System Improvement Act of 1997*, hunting provides traditional recreational activities on the Refuge and in the local area with no definable adverse impacts to the biological integrity or habitat sustainability of the Refuge resources.

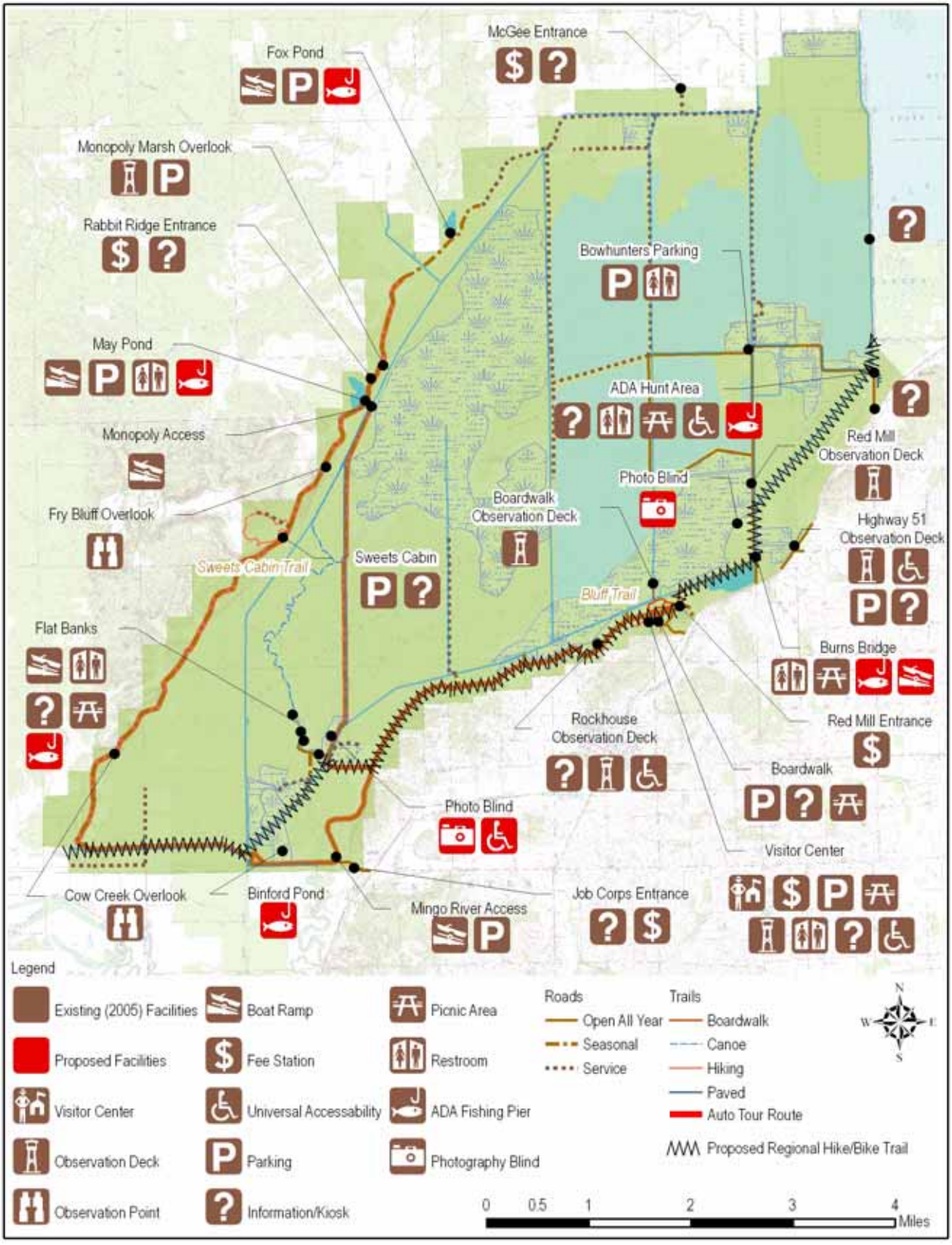
The Refuge has a designated hunting area which consists of 8,960 acres and an additional 6,891 acres during the Managed Deer Hunt, a muzzleloader hunt. The diversity of hunting opportunities include archery deer and turkey hunting, spring firearm turkey hunting, and squirrel hunting. Waterfowl hunting is permitted in Pool 8, a 1,191- acre green tree reservoir. The unit is managed through a cooperative agreement with the MDC as a wade-in hunting area. In 2004, hunting accounted for 3,760 hunting visits with annual increases and decreases in visits based on local conditions.

Refuge management strategies reduce visitor conflicts and provide for a variety of uses through the use of personal contacts and designated hunting and fishing pamphlets and general recreational activities pamphlets. In addition, recreational uses are designated in specific areas, during specific times of the year, and specific durations.

Hunting activities are managed with kiosk information centers and require hunters to sign-in and sign-out and the record the number of hours hunted and any animals harvested. Biologists conduct pre and post hunting season deer surveys to assess the effects of hunting on the population and determine if the Refuge is meeting herd size goal of 800-1,200 deer.

All recreational activities are secondary to the primary purpose in which the Refuge was estab-

Figure 14: Future Facilities, Mingo NWR



lished, and must be compatible. Uses identified in the Refuge Improvement Act (hunting, fishing, wildlife observation and photography, interpretation, and environmental education) receive special recognition by the Service and are accommodated when compatible with the original purpose of the Refuge as a resting and wintering area for migratory waterfowl and other migratory birds.

Strategies:

1. Manage hunts to minimize conflicts with other uses and resources.
2. Maintain good communication with hunters and other user groups so as to minimize conflicts and any friction between different users.
3. Host participants of Missouri Department of Conservation's Spring Turkey Women's Outdoor Skills Event within the public hunting area.
4. Offer educationally based fall youth firearms deer hunt within the public hunting area.
5. Offer Refuge hosted hunter education courses.
6. Offer access to Ditch 3 area by opening Sand Blow Ridge Road year-round except when it is flooded.
7. Request assistance from MDC for muzzleloader hunt.
8. Participate in State waterfowl drawing held at Duck Creek that includes Pool 8.
9. Offer waterfowl hunting on Pool 8 as follows: when the water level reaches a suitable elevation. Provide a maximum of 40 individuals through a daily drawing.
10. Require tree stands to be removed at the end of each day's hunt.

Objective 3.2: Fishing

Within 4 years of plan approval, offer opportunities for 4,500 fishing visits per year while maintaining sustainable resources and providing participants with minimal conflicts with other user groups.

Supporting Rationale

As one of the six priority recreational uses identified in the *National Wildlife Refuge System Improvement Act of 1997*, fishing provides traditional recreational activities on the Refuge and in the local area with no definable adverse impacts to the biological integrity or habitat sustainability of the Refuge resources.

Fisherman on May Pond. USFWS

In 2004, fishing accounted for 2,324 recreational visits to the Refuge. The number of anglers is based on extrapolations from the readings of traffic counters strategically placed at popular destinations. The counters are read at least two times monthly and figures are reported in a public use data base by month. Most anglers visiting the Refuge are families including women, children, and the elderly out for a day-long visit which usually includes picnicking. Approximately 10% of the Refuge anglers access the Refuge by boat or canoe in areas restricting motors. Popular destinations include; Stanley Creek, May and Fox Ponds, Flat Banks, Red Mill Pond, the downstream end of water control structures, and Ditch 11 and other ditches.

In the ditches, improvements in fish species composition and abundance, since ditch cleaning efforts were begun in 1999, are evident. The species most commonly caught are crappie, bass, bluegill, bowfin, and catfish. Periodic assessments of fisheries resources will be utilized to monitor species, relative abundance, and location.

Refuge management strategies reduce visitor conflicts and provide for a variety of uses through the use of personal contacts and designated hunting and fishing pamphlets and general recreational activities pamphlets. In addition, recreational uses are designated in specific areas, during specific times of the year, and specific durations.

All recreational activities are secondary to the primary purpose in which the Refuge was estab-

lished, and must be compatible. Uses identified in the Refuge Improvement Act (hunting, fishing, wildlife observation and photography, interpretation, and environmental education) receive special recognition by the Service and are accommodated when compatible with the original purpose of the Refuge as a resting and wintering area for migratory waterfowl and other migratory birds.

Strategies:

1. Offer fishing from March 1 to September 30 in the area north of Ditch 11 between and including Ditch 2 and Ditch 6.
2. Offer fishing year-round on Ditch 1, Ditch 2, Ditch 6, Ditch 11, Mingo River, Job Corps Lake, Stanley Creek, May Pond, Fox Pond, and Red Mill Pond.
3. Offer fishing from March 1 to September 30 on Ditches 3, 4, 5, Monopoly Marsh, Rockhouse Marsh, and Gum Stump.
4. By 2010 construct a recreational fishing pond in the Binford Unit that would include disabled access and be available for special events.
5. Add universally accessible fishing piers at Flat Banks Entrance Area, Burris Bridge, Ditch 1, May Pond, Fox Pond.
6. Add mowed bank fishing access along ditches, Flat Banks, and Pierman Lane when possible.
7. Offer fishing year-round at the Ditch 5 and Ditch 11 water control structures.
8. Eliminate bow fishing and gigging on the Refuge.

Objective 3.3: Wildlife Observation and Photography

Within 5 years of plan approval, provide a range of wildlife observation and photography opportunities for 75,000 visits per year that allow for viewing a variety of wildlife species and habitats with minimal conflicts with other user groups.

Supporting Rationale

Wildlife observation and photography are both priority public-use activities, which are listed in the *NWRS Improvement Act of 1997*. In 2004, wildlife observation and photography accounted for 71,491 visits. The number of wildlife observer and photographer visits is based on extrapolations from the readings of traffic counters strategically placed at popular viewing and photography destinations. The counters are read at least two times monthly and figures are reported in a public use data base by month.

Facilities that support these activities include the Visitor Center and associated interpretive displays, the Auto Tour Route, eight overlooks and observation platforms, informational kiosks, and five trails, including a five-mile canoe trail and the Boardwalk Nature Trail. The canoe trail offers a wilderness experience of solitude on the Mingo River and opportunities to view and photograph wildlife in a primitive setting.

Refuge management strategies reduce visitor conflicts and provide for a variety of uses through the use of personal contacts, designated hunting and fishing pamphlets and general recreational activities pamphlets. In addition, recreational uses are designated in specific areas, during specific times of the year, and specific durations and group size is limited as needed.

All recreational activities are secondary to the primary purpose in which the Refuge was established, and must be compatible. Uses identified in the Refuge Improvement Act (hunting, fishing, wildlife observation and photography, interpretation, and environmental education) receive special recognition by the Service and are accommodated when compatible with the original purpose of the Refuge as a resting and wintering area for migratory waterfowl and other migratory birds.

Strategies:

1. Along 13 miles of the Auto Tour Route, offer seasonal vehicle access from March 1 through November 30 except for closure during State firearm deer season and as needed during reptile and amphibian migrations.
2. Offer year round vehicle access along 6 miles of the Auto Tour Route, and the entire 5-mile length of Red Mill Drive.
3. Offer year round vehicle access along the entire 3-mile length of Sand Blow Ridge Road.
4. Offer seasonal vehicle access from May 15 through September 30 on the 1 mile road segment between Monopoly Overlook and Fox Pond.
5. Open Auto Tour Route for selected events during winter months (December 1 to end of February).

Refuge staff conducting environmental education on Mingo NWR. USFWS

6. Offer a number of observation sites and structures that include universally accessible sites.
7. Open Monopoly Marsh to public use from March 1 to September 30.
8. Install Web Cam for remote viewing of Refuge.
9. Provide a photo blind/observation site. Potential sites include Red Mill Pond or near Rockhouse Cypress Marsh Overlook.
10. Maintain or improve opportunities for viewing wildlife at overlooks and at selected open fields and farm units.
11. Maintain existing and provide additional foot bridges to improve access to the Refuge.
12. Provide wildlife observation and photography opportunities west of Ditch 6 year round.
13. Provide wildlife observation and photography opportunities east of Ditch 6 to the eastern Refuge boundary from March 1 to September 30.
14. From October 1 to February 28, close to all public use the area between Ditch 4 and Ditch 6 south of Monopoly Marsh to provide an area for wildlife that is free of disturbance.
15. Designate Red Mill Drive as a second auto tour route with interpretive information.

Objective 3.4: Environmental Education and Interpretation

Within 4 years of plan approval, establish an environmental education program that provides a diverse balance of educational topics to over 2,000 students annually.

Supporting Rationale

Environmental education, is one of the six priority public-use activities listed in the *NWRS Improvement Act of 1997*, and generates continued support from area schools and youth conservation groups. Weekly visits by area schools, home school groups, scouts, etc are common with other special programs occurring both on and off the Refuge. In recent years, the Refuge has averaged about 1,800 students for environmental education programs annually. Individual attendees are counted and submitted in the public use database each month.

Programming will be monitored to ensure a variety of programming topics are being presented. When mission is in all programming and four different educational topics are available annually, the environmental education programs will be considered diverse and balanced.

Strategies:

1. Offer environmental education programs for youth groups, schools, and general public with a reptile and amphibian focus at times of the year when they are most likely to be seen.
2. Offer teacher workshops for environmental education.
3. Develop programs specific to Mingo NWR (e.g. ditch system, snakes, waterfowl).
4. Work with scouting groups on merit badge projects.
5. Renovate Hartz Pond and trail for environmental education.
6. Add a full-time (1.0 FTE) Park Ranger to assist with weekend visitor center operations, programming, special events, and maintenance of visitor facilities.
7. Insert more information on reptiles and amphibians in environmental education materials.
8. Continue to maintain existing environmental education facilities and materials.

Objective 3.5: Interpretation

Within 4 years of plan approval, incorporate the agency mission and the purposes of the Refuge into all direct contacts and 75 percent of self-guided interpretive programs.

Supporting Rationale

Interpretation is one of the six priority public-use activities listed in the *NWRS Improvement Act of*

1997. Interpretation on the Refuge focuses primarily on self-guided exhibits, interpretive panels, and brochures. Many facilities are utilized to support this popular use such as the Refuge Visitor Center exhibits, the Boardwalk Nature Trail, the Auto Tour Route, kiosks, and overlooks. In 2004, over 16,000 visits occurred to the Boardwalk Nature Trail, over 8,000 individuals visited the Visitor Center exhibits, over 6,000 visits occurred to the interpretive Auto Tour Route, and over 21,000 individuals visited Refuge interpretive panels and kiosks. The Refuge hosts special events focusing on environmental topics and Refuge specific activities. On-site special events include: Bald Eagle Days, Kid's Free Fishing Day, Migratory Bird Day, National Public Lands Day, and National Wildlife Refuge Week. Every other year, the Refuge and MO DOC host Eagle Days. Bald Eagle Days attracts over 800 individuals annually. Every special event focuses on a Refuge specific interpretive message. Off-site special events conducted by staff include staffed exhibit at the Southeast Missouri District Fair in cooperation with the Missouri Department of Conservation (MO DOC). This event contacts over 25,000 individuals each year. In 2004, over 9,000 individuals were contacted by Refuge staff off-site. Interpretative programming and special events helps foster an appreciation, support, and understanding of the Refuge specific topics and the national wildlife refuge system as a whole.

Strategies:

1. Partner with other agencies for special events.
2. Continue to operate Visitor Center with exhibits during week days year-round and extend operations to include weekends from March 1 to November 30.
3. Develop interpretive panels at Monopoly Overlook.
4. Complete renovation of the Boardwalk Nature Trail.
5. Complete observation platform and interpretive panels along Highway 51.
6. Partner with Friends and others to provide guided wildlife interpretive tours.
7. Develop an annual wildlife festival.
8. Provide historic "living history" programming such as timber harvest with mules.
9. Provide additional interpretive programming along the Auto Tour Route.
10. Develop one or more exhibits on reptiles and amphibians for the Visitor Center.
11. Continue to maintain existing interpretive facilities and materials including the Visitor Center, exhibits, brochures, waysides, etc…
12. Increase off-site outreach efforts to attract long distance visitors.
13. Insert more information on reptiles and amphibians in interpretive materials.

Objective 3.6: Other Compatible Recreational and Consumptive Uses

Throughout the life of the plan, provide compatible opportunities for horseback riding, canoeing, biking, hiking, jogging, and gathering of wild edible plants for a total of 2,300 visits per year.

Supporting Rationale

The *NWRS Improvement Act of 1997* identifies six priority public uses: hunting, fishing, wildlife observation and photography, and environmental education and interpretation that receive enhanced consideration over other general public uses in planning and management of the Refuge System. Other uses can occur but must support a priority public use or not conflict with priority public uses. No use of a national wildlife refuge can detract from accomplishing the purposes of the Refuge or the mission of the System.

Mingo NWR supports various forms of nature-based outdoor recreation that, while not exactly wildlife-dependent, may well be compatible with the purposes of the Refuge and contributes to public appreciation and enjoyment of it. These include equestrian use, canoeing, bicycling, hiking, jogging, and gathering of wild edibles. In 2004, a total of 2,385 visits for these activities occurred. The number of visits is based on extrapolations from the readings of traffic counters strategically placed at popular destinations, and individual sightings of individuals engaged in these activities. The counters are read at least two times monthly and figures are reported in a public use data base by month.

Berry, mushroom, pokeweed, and nut gathering are non-wildlife dependent activities that occur near the Rockhouse Overlook and along Bluff Drive. These activities are permitted outside the Wilderness Area as long as the ground is not disturbed.

Horseback riding on the Refuge has local support from area riding clubs, who continue to use the

Refuge on an annual basis for single rider and group rides along portions of the Auto Tour Route. Impacts to biological resources, such as the introduction of invasive species and disturbance to wildlife during periods of migration, are a continuing concern.

Hiking continues to occur on Refuge trails while bicycling has become increasingly poplar in recent years along the established roadways. Likewise, canoeing has become more and more poplar with small groups and wilderness enthusiasts seeking solitude. Refuge management guidelines, legal mandates, and policies, such as the Wilderness Act of 1964, require compatibility and form a standard to help minimize conflicts among user groups while protecting resources and wildlife habitat.

Refuge management strategies reduce visitor conflicts and provide for a variety of uses through the use of personal contacts, designated hunting and fishing pamphlets and general recreational activities pamphlets. In addition, recreational uses are designated in specific areas, during specific times of the year, and specific durations and group size is limited as needed.

Strategies:

1. Offer year round access for horseback riding, recreational biking, hiking, and jogging along the entire 19-mile length of the Auto Tour Route and along the entire 5-mile length of Red Mill Drive.
2. Offer year round access for horseback riding, recreational biking, hiking, and jogging along the entire 3-mile length of Sand Blow Ridge Road.
3. Offer seasonal access from March 1 through September 30 for horseback riding, recreational biking, hiking, and jogging along a 6-mile loop between Ditch 3 and Ditch 4.
4. Offer seasonal access from May 15 through September 30 for horseback riding, recreational biking, hiking, and jogging on the 1 mile road segment between Monopoly Overlook and Fox Pond.
5. Offer year round access for horseback riding, recreational biking, hiking, and jogging along a 6-mile length of Bluff Road.
6. Evaluate and authorize equestrian use, recreational biking, canoeing, and jogging involving group events through a permitting process.
7. Provide for the regional bike route to pass through the Refuge along existing roads and (improved) levee tops.
8. Maintain existing hiking trails and canoe trails.
9. Offer boating, canoeing, and kayaking from March 1 to September 30 in the area north of Ditch 11 between and including Ditch 2 and Ditch 6.
10. Offer boating, canoeing, and kayaking year-round on Ditch 1, Ditch 2, Ditch 6, Ditch 11, Mingo River, Job Corps Lake, Stanley Creek, May Pond, Fox Pond, and Red Mill Pond.
11. Offer boating, canoeing, and kayaking from March 1 to September 30 on Ditch 3, Ditch 4, Ditch 5, Monopoly Marsh, Rockhouse Marsh, and Gum Stump.
12. Offer gathering of one-half gallon per day of mushrooms and berries and five gallons per day of pokeweed for personal use and without ground disturbance in the areas south of Ditch 11 and east of Ditch 6 from March 1 to September 30. Possession or harvest outside this area is prohibited.
13. Provide year-round boating access to Ditch 11 at Burris Bridge, and Flat Banks.
14. Phase out all grills and concentrate picnic tables near areas of high public use.

Goal 4: Resource, Facility, and Visitor Safety and Protection

Protect natural, cultural, and man-made resources and provide for the safety of staff, volunteers, and visitors to the extent feasible.

Objective 4.1: Archeological, Cultural, and Historic Protection

Over the life of the plan, avoid and protect against disturbance all known cultural, historic, or archeological sites (presently more than 140 sites).

Supporting Rationale

Cultural resources are an important facet of the country's heritage and Mingo NWR, like all national wildlife refuges, remains committed to preserving archeological and historic sites against degradation, looting, and other adverse impacts. The guiding principle for management occurs in the *National Historic Preservation Act of 1966 as amended, 16 U.S.C. 470 et seq.* and the *Archeological Resources Protection Act of 1979 as amended, 16 U.S.C. 47011-mm* which establish legal mandates and protection against identifying sites for the public, etc. Archeological surveys of

the Refuge, including the Mingo Job Corps campus, have now been completed on almost 7,200 acres of the Refuge.

More than 140 cultural resources sites have been identified to date on the Refuge. These sites represent all Midwest United States cultural periods from the earliest Paleo-Indian through 20th century Western, a period of about 12,000 years. One standing structure on the Refuge, the Sweet's (or Patrol) Cabin, a Depression-Era structure from the early 20th century, is considered eligible for the National Register of Historic Places. The importance of the cultural resources on the Refuge is evident with the Mingo NWR Archeology District having status on the National Register Places.

Management of the rich cultural resources on the Refuge must include awareness of maintaining architectural integrity of historic structures, avoidance of ground disturbance practices and public activities, such as the picking up of arrowheads from plowed fields, and a continuing vigilance to safeguard these regional and national treasures. It is also essential that the Refuge document new site discoveries. It is also important for Refuge management to maintain an open dialogue with the Regional Historic Preservation Officer (RHPO) and to provide the RHPO with information about new archeological site discoveries.

Strategies

1. Conduct site-specific surveys prior to ground disturbing projects and protect known archeological, cultural and historic sites.
2. Within 10 years of CCP approval, complete a Cultural Resources Management Plan (CRMP) and start to implement recommendations and procedures over the remaining life of the CCP.
3. Determine National Register eligibility of known sites.
4. Inform the Regional Historic Preservation Officer early in project planning to ensure compliance with Section 106 of National Historic Preservation Act.
5. Contract with cultural resources firms specializing in Missouri to conduct Phase I surveys prior to undertakings that could adversely affect historic resources.
6. In the event of inadvertent discoveries of ancient human remains, follow instructions and procedures indicated by the RHPO.
7. Ensure archeological and cultural values are described, identified, and taken into consideration prior to implementing undertakings.
8. Complete Phase I archeological surveys of the non-flooded areas of the Refuge, by qualified personnel when the RHPO determines surveys are necessary.
9. Identify, inventory, preserve, and protect early settler grave sites on the Refuge.

Objective 4.2: Wilderness Area Management and Protection including Research Natural Areas

Protect and maintain the wilderness and biological character of the 7,730-acre, Class I Mingo Wilderness Area.

Supporting Rationale

In 1964, Congress passed the Wilderness Act, which established the National Wilderness Preservation System. The legislation set aside certain federal lands as wilderness areas. The act says that such lands are areas "…where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." In 1976, Congress designated 7,730 acres of swamp, riparian areas, and Ozark Plateau uplands as the Mingo Wilderness Area. This is an area with numerous tributaries forming a storage watershed in the Monopoly Marsh and Mingo River basin. A series of ditches and levees adjacent to the Wilderness Area help approximate hydrologic conditions that once occurred naturally.

A large diversity of flora and fauna exists within this system which is home to indigenous species, such as river otter, bowfin, hairy-lip fern, and nesting Bald Eagles. The Wilderness Area also serves as an important wintering area for migratory waterfowl and critical habitat for swamp rabbits, Wood Ducks, migrating monarch butterflies, and other species. As the largest remaining tract of bottomland hardwood forest in Missouri, the Mingo Wilderness depends on the safeguards of the Wilderness Act of 1964, the Clean Air Act Amendments of 1990, Public Law 94-557, and the Draft Wilderness Stewardship Policy of 2001. These laws are important to protect against a loss of wilderness character leading to a loss of biological integrity and degradation of air and water quality, as well as adverse impacts of invasive spe-

cies such as feral hogs, nutria, Sericia, etc. Other potential negative impacts also occur from the increase in human-use demands on the resources. Minimum tool analysis and other management guidelines help address potential human impacts and their effects and further safeguard against encroachments such as "temporary roads, motor vehicles, motorized equipment, motorboats, mechanical transport, landing of aircraft, structures, and installations." While motorized recreational activities are prohibited inside the Mingo Wilderness Area, motorized traffic does occur along non-wilderness corridor roads alongside a network of waterways. Hiking, backpacking, fishing, wildlife observation, environmental education and interpretation are allowed, as well as biological research as approved through Refuge Management.

There are seven research natural areas on the Refuge, six of which are located within the Mingo Wilderness Area. Each research natural area is part of a national network of reserved areas under various ownerships intended to represent the full array of North American ecosystems with their biological communities, habitats, natural phenomena, and geological and hydrological formations. In research natural areas, as in designated wilderness, natural processes predominate without human intervention.

Strategies:

1. Preserve and protect wilderness values within the area through proper signage, keeping out unauthorized entry, etc.
2. Inspect the perimeter of the Wilderness Area at least once every 3 years to replace signs that have fallen, disappeared, been damaged or vandalized.
3. Inspect interior of Wilderness Area at least once every 3 years to monitor for habitat changes, succession and any signs of unauthorized human disturbance.
4. Install Webcam at a location that shows daily and seasonal habitat changes and recreational activities.
5. Install photo monitoring sites that encompass the Monopoly Basin to help monitor air quality.
6. Implement the "Leave No Trace" program to teach the public about minimizing impacts to Wilderness Area.

Doe on Mingo NWR. USFWS

7. Ensure that one or more of the Refuge staff have received Service training in wilderness management, including Minimum Tool Analysis.
8. Conduct air and water quality monitoring within the Wilderness Area (e.g. mercury contamination).
9. Mimic natural hydrology within Wilderness Area.

Objective 4.3: Contaminants

Over the life of the plan, maintain water and airborne contaminants at levels that meet or exceed Missouri Department of Natural Resources and Environmental Protection Agency standards.

Supporting Rationale

Mercury has been detected on the Refuge, but has not been measured in a consistent manner, so exact levels and the degree of present risk to wildlife and humans are not known. One study (Mercury Levels in Water and Fish Tissue Samples from Mingo Swamp National Wildlife Refuge, G. Bruland, 1995) offered preliminary results indicating mercury levels in fish tissue ranging from 0.9 to 2.5 ppm.. These are concentrations which indicate that

there is a problem with mercury contamination of the fish in the system.

Air quality monitoring for nitrates and sulfates of the Mingo Wilderness Area indicate that Mingo's Class I Area is one of the more polluted areas of the 23 sites the Service manages (U.S. Fish and Wildlife Service Region 3 Air Quality Briefing, January 23, 2004). The 2001 Total Annual Light Extinction Rates indicate that Mingo has almost four times higher than the natural visibility conditions according to the U.S. Environmental Protection Agency "Draft Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program". The Refuge works cooperatively with the Air Quality Branch of the Service in Denver, Colorado on evaluating requested air permits from various manufacturing companies. Goals of the air quality program, based on the Clean Air Act and Wilderness Act, are to assess potential hazards and protect the Mingo Class I Wilderness Area from air pollutants causing visibility concerns.

Strategies

1. Within 5 years of CCP approval, expand the program to include monitoring on a regular basis of fish, reptiles and amphibians, sediments, and water quality for contamination by a variety of toxins. Also, conduct monthly drinking water tests to comply with State regulations, and periodically conduct more detailed tests of other contaminants like nitrates, leads, other heavy metals, etc.
2. Ensure that employees collecting different kinds of environmental quality and contaminant samples are adequately trained in standard procedures for sampling.
3. Establish sites for repeated sampling to build a baseline of comparable data, and obtain information from other locations to expand breadth of data and reduce risk that localized problems are not being overlooked.
4. Conduct cooperative research on mercury and other contaminants.

Objective 4.4: Visitor and Employee Safety

Over the life of the plan, limit reported incidents to 20 per 100,000 visits per year.

Supporting Rationale

Over the last 5 years, the Refuge has received at least 100,000 visitors annually participating in all six priority Refuge recreation activities demanding the need for safety precautions. Numerous hazards exist on the Refuge including poisonous snakes, falling trees, road hazards, becoming lost while hunting/hiking, rock cliffs, and poisonous plants. The Refuge contains a variety of natural and cultural resources that in addition to facilities, infrastructure, and equipment require protection both from human neglect and malfeasance as well as from natural disasters and time. A safety inspection of all facilities and grounds occurs annually with corrective measures taken on hazardous findings to provide a safe environment for both visitors and staff. Two dual-function Refuge Officers spend a minimum of 25 percent of their duty hours conducting regular patrols of all grounds to ensure public safety. Refuge Officers and several Refuge personnel are trained in CPR and First Aid. A Mingo Search and Rescue Team composed of volunteers and staff exists to assist with lost hunters and hikers.

In recent years, the Refuge has received approximately 24 reported incidents per 100,000 visits per year. Reported incidents include: safety concerns with equipment, facilities, and infrastructure utilized by staff and volunteers and reports of safety concerns by visitors, researchers, and other authorized users of the Refuge's infrastructure and facilities supporting recreation, administration, and/or biology.

Strategies

1. Provide regular law enforcement patrol, respond to search and rescue cases, and maintain facilities and infrastructure in compliance with OSHA and other regulations, educate public on environmental hazards.
2. Continue close cooperation with MDC agents, Stoddard County and Wayne County deputies, and the State Patrol.
3. Continue the Refuge-sponsored Search and Rescue Team with a designated Refuge Coordinator.
4. Expand law enforcement patrol.
5. Maintain all facilities and infrastructure in compliance with OSHA and other regulations.
6. Install electric gates at entrances.
7. Add signage and information in the brochure about dangerous wildlife and other Refuge hazards.
8. Expand Visitor Center hours to include weekends from March 1 through November 30.

9. Increase staffing by 0.8 FTE for roadside mowing and facility/road maintenance to provide safe environment for visitors and employees.

Objective 4.5: Resource Protection

Over the life of the plan, limit the amount of documented incidents of illegal activities to 1 incident per 60 hours of law enforcement effort.

Supporting Rationale

Two Refuge staff members have law enforcement authority and work closely with Missouri Department of Conservation agents and Stoddard County deputies. The number of public contacts far exceeds the citations and warnings issued during a year. Past violations have included trespass, poaching, illegal possession of a firearm in an area closed to weapons, artifact collection, hunting in closed areas, and not paying entrance fees. Problems of stray hunting dogs, vandalism, and litter exist, but violators are not often caught. Dual-function Refuge Officers spend a minimum of 25 percent of their duty hours conducting regular patrols and investigations to ensure resource protection.

Although wildfires on the Refuge have been relatively rare, the potential exists for resource damage by fire under extremely dry conditions. Two Refuge staff members currently are qualified as wildfire firefighters and cooperative agreements are in place with four Rural Fire Districts surrounding the Refuge.

The present level of documented incidents of illegal activities is one incident per 60 hours of law enforcement effort.

It is expected that as law enforcement effort increases, the amount of documented incidents should increase, because as an officer spends more time and effort in the field, he/she becomes more aware of incidents and issues more notices of violations and warnings. These efforts, along with preventative law enforcement efforts such as distribution of literature that highlights areas often overlooked by Refuge visitors and explains Refuge specific requirements, will result in a reduction of documented incidents. In time, the initial increase in the number of documented incidents will level off and show an appreciative decline as the local community and visiting public become more aware and compliant regarding Refuge regulations.

Strategies:

1. Continue close cooperation with MDC agents, Stoddard County and Wayne County deputies, and the State Patrol.
2. Enhance the relationship with U.S. District Attorney's Office.
3. Increase boundary and interpretive signage and distribution of Refuge-specific regulatory information.
4. Conduct electronic surveillance.
5. Develop additional cooperative law enforcement efforts with local, state, and federal law enforcement organizations.
6. Obtain a full-time (1.0 FTE) law enforcement officer.
7. Increase law enforcement efforts to prevent poaching of Refuge resources.
8. Revamp Refuge regulations and general activities pamphlets to improve clarity and understanding of Refuge-specific regulations.
9. Annually inspect areas where most wild edibles gathering has occurred to check for any habitat damage, erosion, litter, etc.
10. Conduct periodic inspections of sites known to be popular with gatherers and incidental inspections of visitors in those areas carrying bags, baskets or other containers that might be carrying wild edibles.

Goal 5: Off Refuge Conservation

Preserve, protect, and enhance Refuge Integrity and encourage conservation beyond Refuge boundaries.

Objective 5.1: Reducing Sedimentation from Off-Refuge Sources

Over the life of the plan, decrease the amount of sediment entering the Refuge to levels to be determined within 7 years of plan approval.

Supporting Rationale

For decades, Mingo Swamp has been a sediment trap for sediments transported and deposited from the watershed upstream. Rainfall on sloping sites that have been recently cleared, logged, grazed or cultivated is prone to cause erosion and runoff, which in turn generate sediments. These sediments are then deposited in the Mingo NWR drainage ditch system, where the water current loses velocity and no longer has the energy to carry its sediment load. The accumulation of sediment in the ditches has reduced not only the water-holding and transporting capacity of the

ditches themselves, but has damaged habitats by substantially reducing the ability to drain water, and provide deep water habitat for aquatic resources.

Strategies:

1. Over the life of the plan carry out strategic wetland restoration along the watershed of Duck Creek Bottoms.
2. Over life of the plan, expand private landowner duck-hunting and wildlife observation opportunities from wetland restoration along the watershed of Duck Creek Bottoms.
3. Partner with MDC, Little River Drainage District and private landowners to reduce sediment entering the Refuge by implementing projects upstream on watersheds entering the Refuge.
4. Approach landowners individually or in a meeting arranged by the Refuge to consider cooperative efforts to carry out wetland restoration.
5. Explore the possibility of using the Wetland Reserve Program or Conservation Reserve Programs to help fund wetland restoration on private lands.
6. Try to enlist the support of local, regional, and national waterfowl hunting organizations like Ducks Unlimited.
7. Concentrate conservation efforts along Stanley Creek, Kawker Creek, Brush Creek, McGee Creek, Slage Creek, Cane Creek, Dry Creek, Malone Creek, Glassed Creek, and Lick Creek.

Hermit Thrush. USFWS

8. Add 0.5 FTE Biotech to conduct inspections and assist in Wetland Reserve Program and wetland restoration.
9. Identify lands near the Refuge, totaling 10 percent or less of existing Refuge acreage (approximately 2,100 acres), for possible acquisition.
10. Work with the Natural Resources Conservation Service, Farm Services Agency, and Missouri Department of Conservation to establish conservation easements with land owners in the Stanley Creek watershed.
11. Use a variety of methods to seed, plant, level or otherwise cover exposed banks and slopes to reduce erosion and sedimentation.
12. Work with the EPA and others to asses the sedimentation rate and establish acceptable thresholds.

Objective 5.2: Rural Economic Development and Easements

Over the life of the plan, ensure compliance of conservation easements and restore and enhance wildlife habitat on 17 sites totaling 448 acres.

Supporting Rationale

The Farm Services Administration (FSA) makes loans to farmers and ranchers temporarily unable to obtain credit from commercial lending institutions. The FSA sometimes obtains title to real property when a borrower defaults on a loan secured by the property, and then the agency will hold and eventually dispose of the land. The Service participates in the inventory of properties that contain or support significant fish and wildlife resources or have current, former or degraded wetlands that can be restored, or other unique habitats that merit protection.

Mingo NWR manages 17 FSA conservation easements comprising approximately 448 acres within a 48 county region in the southern third of Missouri. All easement properties are to be inspected, have management plans, and be posted with signs indicating the properties are under conservation easements. Conservation Easements are considered to be units of the National Wildlife Refuge System and are required to comply with all regulations governing Chapter 50 of the Code of Federal Regulations.

Strategies:

1. Enhance efforts for compliance reviews and restoration opportunities by conducting

annual site inspections and reviews on at least nine sites.

2. Maintain an archive of records, files and photographs for each property to monitor progress towards habitat enhancement.
3. Cooperate closely with the FSA.
4. Increase cooperation with the FSA in visiting new sites with potential wildlife or habitat value.
5. Add 0.5 FTE Biotech to assist with inspections and restoration work on easements.
6. Use 15 percent of full-time law enforcement officer for compliance inspections.

Goal 6: Human Resources and Facilities

Seek opportunities to obtain sufficient human resources and facilities through partner and agency funding mechanisms to achieve the goals and objectives of the CCP.

Objective 6.1: Refuge

Throughout the life of the plan, establish the Refuge as a sound investment that adds value through natural resource management.

Supporting Rationale

The implementation of CCP strategies requires a commitment from many organizational levels. Refuge projects are successfully funded when forethought and linkage to mission, goals, and objectives can be demonstrated. When grass-root support of the Refuge exists, Congressional interest and involvement occurs, and interagency partnerships are created, many projects become actualized and the Refuge develops credibility. Creative work force planning, partnerships, and utilizing supplemental funding opportunities are routes to successfully implement CCP recommendations.

Strategies:

1. Cultivate good relations with local neighbors, officials, and the media.
2. Document funding needs precisely through memos and reports.
3. Conduct site visits for USFWS and other federal officials (e.g. Congressional offices) to showcase the Refuge's achievements and needs; select a location and time of year that will best highlight these needs and accomplishments.
4. Demonstrate precisely what would be gained for the Refuge and the local community if sufficient support were to be received.
5. Utilize the local media to promote Refuge habitat improvements, outreach activities, and other accomplishments.
6. Coordinate with Friends and other users groups (e.g. Wild Turkey Federation, Ducks Unlimited, Audubon, Wilderness Society etc.) to actively explore opportunities to promote compatible wildlife-dependent recreation on the Refuge.
7. Cooperate with organizations like The Nature Conservancy and Mingo Job Corps on habitat improvement projects.
8. Implement a year-round fee system to assist with public use administration and infrastructure improvements.

Pilot Knob National Wildlife Refuge Goals, Objectives and Strategies

Goal 1: Endangered Species

Contribute to the recovery of federally-listed species and the conservation of their subterranean habitat on the Refuge.

Objective 1.1: Law Enforcement

Throughout the life of the plan, limit the amount of documented incidents of illegal activity to 1 incident per 60 hours of law enforcement effort.

Supporting Rationale

Complications to the management of Pilot Knob NWR include a lack of local Refuge personnel to randomly patrol the area and not possessing an uncontested easement to the Refuge boundary. During public scoping for Pilot Knob NWR, some people suggested that the Service enter into a cooperative agreement with the Missouri Department of Conservation or some other local agency to assist with management or law enforcement on the Refuge. The staffing of the adjoining state park has a more historical focus than biological with their primary interest being the preservation of the Civil War Era battlefield; however, a Conservation Officer does reside locally.

The present (2005) level of documented incidents of illegal activity is 7.5 incidents per 60 hours of law enforcement effort. Past documented incidents of illegal activities include vandalism, wildlife disturbance while bats were hibernating, litter, and trespass.

Strategies:

1. Define and upgrade existing access or acquire a new access to the Refuge.

Wildlife observation is a priority public use on national wildlife refuges. USFWS

2. Repair fencing and maintain boundary signs to help reduce illegal access.
3. Track law enforcement reports to detect trends in illegal activity at the Refuge.
4. Issue and monitor special use permits.
5. Develop a cooperative agreement with Missouri Department of Conservation to share law enforcement on the Refuge.
6. Initiate a Friends group or similar body to act as a "neighborhood watch" to assist in monitoring activity on the Refuge.

Objective 1.2: Bat Recovery

Over the next 15 years, contribute to the stabilization or increase of Indiana bat and gray bat numbers by protecting the hibernaculum found on the Refuge.

Supporting Rationale

Indiana bat and gray bat are federally endangered species. The Refuge is listed as critical habitat for the Indiana bat and is one of nine Priority One hibernacula identified in the Indiana Bat Recovery Plan. Historically, the hibernaculum provides annual winter habitat for at least 30,000 Indiana bats.

Strategies

1. Work with MDC, MDNR, and other partners to implement State and Federal recovery plans for the Indiana bat and gray bat.
2. Place barriers to restrict access to chasm leading to abandoned mine entrance.
3. Develop a survey protocol approved by the Indiana Bat Recovery Team for monitoring wintering bats within inaccessible hibernacula.
4. Investigate stabilizing the mine entrance to prevent its collapse.

Goal 2: Refuge Visibility

Local residents and visitors are aware of the Refuge and its purpose.

Objective 2.1: Public Access and Visitor Services

Within 5 years of plan approval, allow up to 100 visitors per year guided access to the Refuge.

Supporting Rationale

During public scoping held at the outset of the CCP process, it became evident that local residents support allowing public use of the Refuge. The summit of Pilot Knob is unique geologically and offers a panoramic view of the surrounding area, including a Civil War battlefield, Fort Davidson. Supporters believe access can be provided while protecting both bats and public safety. It has been suggested that public access and visitor services could use guided tours during times when little disturbance to the Indiana and gray bats might occur. This will further educate the local public about the importance of the bat species to people and local business and provide a biological balance, as to the need to protect the species.

All recreational activities are secondary to the primary purpose in which the Refuge was established, and must be compatible. Uses identified in the Refuge Improvement Act (hunting, fishing, wildlife observation and photography, interpretation, and environmental education) receive special recognition by the Service and are accommodated when compatible with the original purpose of the Refuge to conserve fish or wildlife which are listed as endangered or threatened species.

Strategies:

1. Place barriers to restrict access to the chasm leading to the abandoned mine entrance.
2. Establish a minimally developed administrative/maintenance access road passable by a four-wheel drive vehicle for implementing public use activities.

3. Accurately locate and map (using GPS and GIS technology) mine entrances and other potential hazards.
4. Develop a Refuge brochure.
5. Add 0.5 FTE Refuge Operations Specialist (5/7/9) to oversee biological monitoring, maintenance, cooperative agreements, interpretive programming, and outreach.
6. Explore a partnership with Fort Davidson State Historic Site to assist with guided tours.
7. Explore seasonal closure of the Refuge to avoid disturbing hibernating bats.
8. Use appropriate methods to avoid hazards and provide for visitor safety.
9. Work with local residents to form a Friends group or some similar body to communicate information and support the Refuge.
10. Evaluate the feasibility and compatibility of an observation platform on the summit of Pilot Knob.

Ozark Cavefish National Wildlife Refuge Goals, Objectives and Strategies

Goal 1: Endangered Species

Contribute to the recovery of federally listed species and the conservation of other subterranean species and their habitats within the Springfield Plateau.

Objective 1.1: Habitat Management

Within 10 years of plan approval, document historic conditions, collect current data on vegetation composition consistent with standards of the National Vegetation Classification System, and identify opportunities for habitat restoration.

Supporting Rationale

The Refuge consists of 40 acres along Turnback Creek in Lawrence County and a 1-acre tract located at Hearrell Springs near the Neosho National Fish Hatchery. Habitats present on Ozark Cavefish NWR include the terrace bottoms community (well-drained and rarely flooded transitional areas that support a mixture of upland and floodplain woody species); the mixed hardwood-softwood levees community along drainage ditch levees, stream margins, roadside embankments, and other watercourse borders; the upland old fields community, including scattered woodland clearings, abandoned fields or pastures, and ridge roadsides reverting to oak-hickory forest; and the xeric ridge crests community, the driest and most exposed forest community, which occurs on ridge crests, bluff tops, and upper slopes on thin, excessively drained soils. To date, the Service has conducted no habitat management at Ozark Cavefish NWR.

Strategies

1. Develop a cooperative agreement with Missouri Department of Conservation to share management activities of the Refuge.
2. Develop and begin implementation of a Habitat Management Plan.
3. Add 0.5 FTE Refuge Operations Specialist (5/7/9) to oversee Refuge management including habitat management, implementing recovery plans, building and maintaining partnerships, and managing visitor services.

Objective 1.2: Visitor Services and Public Awareness

Within 10 years of plan approval, 33 percent of a randomly selected sample of residents within the Turnback Creek and Hearrell Spring recharge areas will recognize the purpose of the Refuge.

Supporting Rationale

Presently there is no active promotion of the Refuge other than a brochure and website. During public scoping for the CCP, the Missouri Department of Conservation suggested opening the Refuge to public use, which would contribute greatly to public awareness of it and necessitate at least minimal visitor services and facilities. Permitting limited public use would make it consistent with access to the Paris Springs, an adjoining State-owned property that contains the entrance to Turnback Cave. A greater awareness of water quality issues may result in land use improvements in the watersheds of the Ozark Cavefish and in turn contribute to the recovery of the species.

Strategies:

1. Maintain web cam at Hearrell Spring and provide interpretation.
2. Develop a cooperative agreement with Missouri Department of Conservation to share public use management of the Refuge.
3. Allow only scientific, educational, and interpretive uses at Hearrell Spring portion of Refuge.
4. Install educational/interpretive kiosks at Hearrell Spring and Turnback Creek portions of Refuge.

5. Offer compatible wildlife dependent recreation at the Turnback Creek portion of the Refuge.
6. Develop a cooperative agreement with Neosho National Fish Hatchery to share management and oversight of the Hearrell Spring portion of the Refuge located in Neosho, Missouri near the hatchery.

Objective 1.3: Law Enforcement

Throughout the life of the plan, limit the amount of documented incidents of illegal activity to 1 incident per 60 hours of law enforcement effort.

Supporting Rationale

Presently, there are infrequent law enforcement inspections of the Refuge. With no local personnel, its closure to the public is difficult to enforce. Fencing and signage likely reduces the number of trespass violations, but seasonal patrols during hunting seasons and other peak usage periods are needed to monitor compliance levels. Threats associated with fire or destruction of habitat are not presently monitored on a regular basis.

The present (2005) level of documented incidents of illegal activity is 22.5 incidents per 60 hours of law enforcement effort. Past documented incidents of illegal activities include trespass and poaching.

Strategies

1. Develop a cooperative agreement with the Missouri Department of Conservation to share law enforcement oversight of the Refuge.
2. Post and maintain Refuge boundaries.

Goal 2: Water Quality

Landowners in the recharge areas of the Refuge apply best management practices to maintain water quality.

Objective 2.1: Recharge Area Conservation

At least 75 percent of landowners in the Turnback Creek recharge area will be presented with information regarding the relationship between best management practices and water quality and encouraged to apply the practices.

Supporting Rationale

Currently there is no active program to improve water quality within the recharge areas for Turnback Creek or Hearrell Springs. During public scoping for the CCP, several commenters observed that protecting and conserving recharge areas for streams known to contain Ozark cavefish would provide the greatest protection for the species. Hazardous material spills along Highway 44 within the recharge area for Turnback Creek pose a potential risk to the Ozark cavefish on the Refuge: spill could not only contaminate surface water, but also have adverse effects on the Ozark cavefish and other subterranean species.

Strategies

1. Coordinate with the Missouri Department of Conservation on Turnback Cave recharge area mapping.
2. Explore the need for mapping the recharge area of Hearrell Spring portion of Refuge.
3. Work with the Service's Partners for Wildlife program and the Missouri Department of Conservation's private lands programs to develop a landowner education program, and to assist in the restoration of habitats that would contribute to the conservation of the recharge area.
4. Work with Missouri Department of Conservation, Missouri Department of Natural Resources, Missouri Department of Transportation, landowners, and others to develop mitigation measures for hazardous materials spills.
5. Monitor water quality at various locations in the recharge area and communicate trends to landowners.